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The horizontal and vertical circulation of the Weddell Gyre is diagnosed using a box inverse model constructed with recent hydrographic sections and including mobile sea ice and eddy transports. The gyre is found to convey 42 ± 8 Sv (1 Sv = 10^6 m^3 s^{-1}) across the central Weddell Sea and to intensify to 54 ± 15 Sv further offshore. This circulation injects 36 ± 13 TW of heat from the Antarctic Circumpolar Current to the gyre, and exports 51 ± 23 mSv of freshwater, including 13 ± 1 mSv as sea ice to the mid-latitude Southern Ocean. The gyre's overturning circulation has an asymmetric double-cell structure, in which 13 ± 4 Sv of Circumpolar Deep Water (CDW) and relatively light Antarctic Bottom Water (AABW) are transformed into upper-ocean water masses by mid-gyre upwelling (at a rate of 2 ± 2 Sv) and into denser AABW by downwelling focussed at the western boundary (8 ± 2 Sv). The gyre circulation exhibits a substantial throughflow component, by which CDW and AABW enter the gyre from the Indian sector, undergo ventilation and densification within the gyre, and are exported to the South Atlantic across the gyre's northern rim. The relatively modest net production of AABW in the Weddell Gyre (6 ± 2 Sv) suggests that the gyre's prominence in the closure of the lower limb of global oceanic overturning stems largely from the recycling and equatorward export of Indian-sourced AABW.